Massachusetts Institute of Technology
C. S. Draper Laboratory
Cambridge, Massachusetts

LUMINARY Memo #165

To: Distribution
From: D. Eyles
Date: 28 July 1970
Subject: The Return of R10FLAG

This memo is a sequel to Luminary Memo #162 which described a new Landing Analog Displays routine, developed in ZERLINA and, since the earlier memo was written, approved for implementation in the September release of LUMINARY 1D. In particular, part E of the earlier memo is superceded by what comes next.

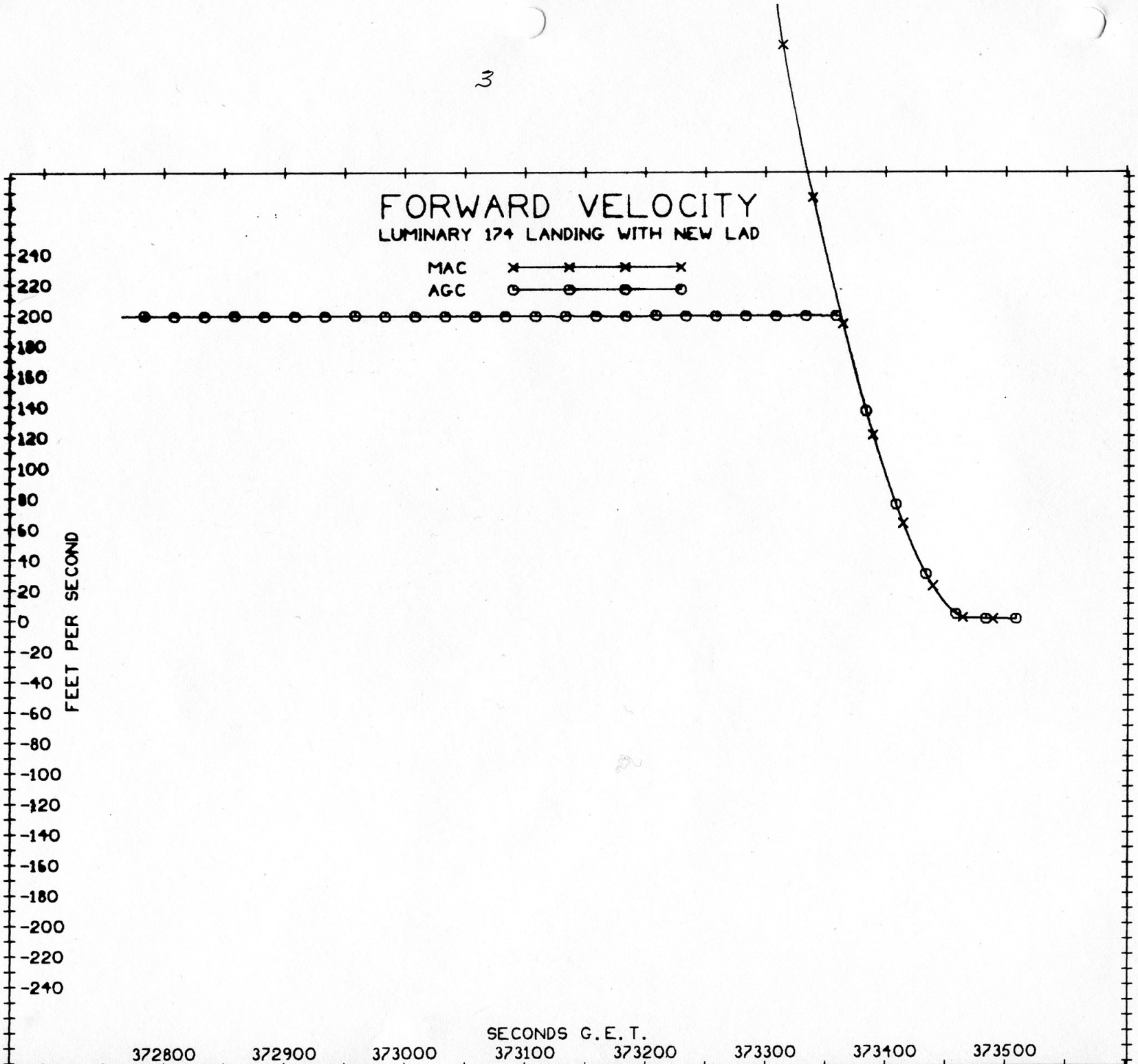
The cross-pointer display maintained during Descent is of forward and lateral velocity relative to the Lunar surface and defined in terms of yaw so as to be LM body z-axis and y-axis velocity when the vehicle is erect. It was thought desirable to provide this display for Ascent (and Aborts) also, and so it was until, in Tindall's meeting on July 22, it was learned from Gene Cernan that this display is not suitable for Ascent because a yaw manoeuvre, which might occur for communications reasons, would throw lateral velocity off the scale (± 200 f/s) and destroy its usefulness as a monitor of the out-of-plane component of the Ascent burn. It was left to MIT to decide whether to provide no display or a meaningful display on the cross-pointers during Ascent.

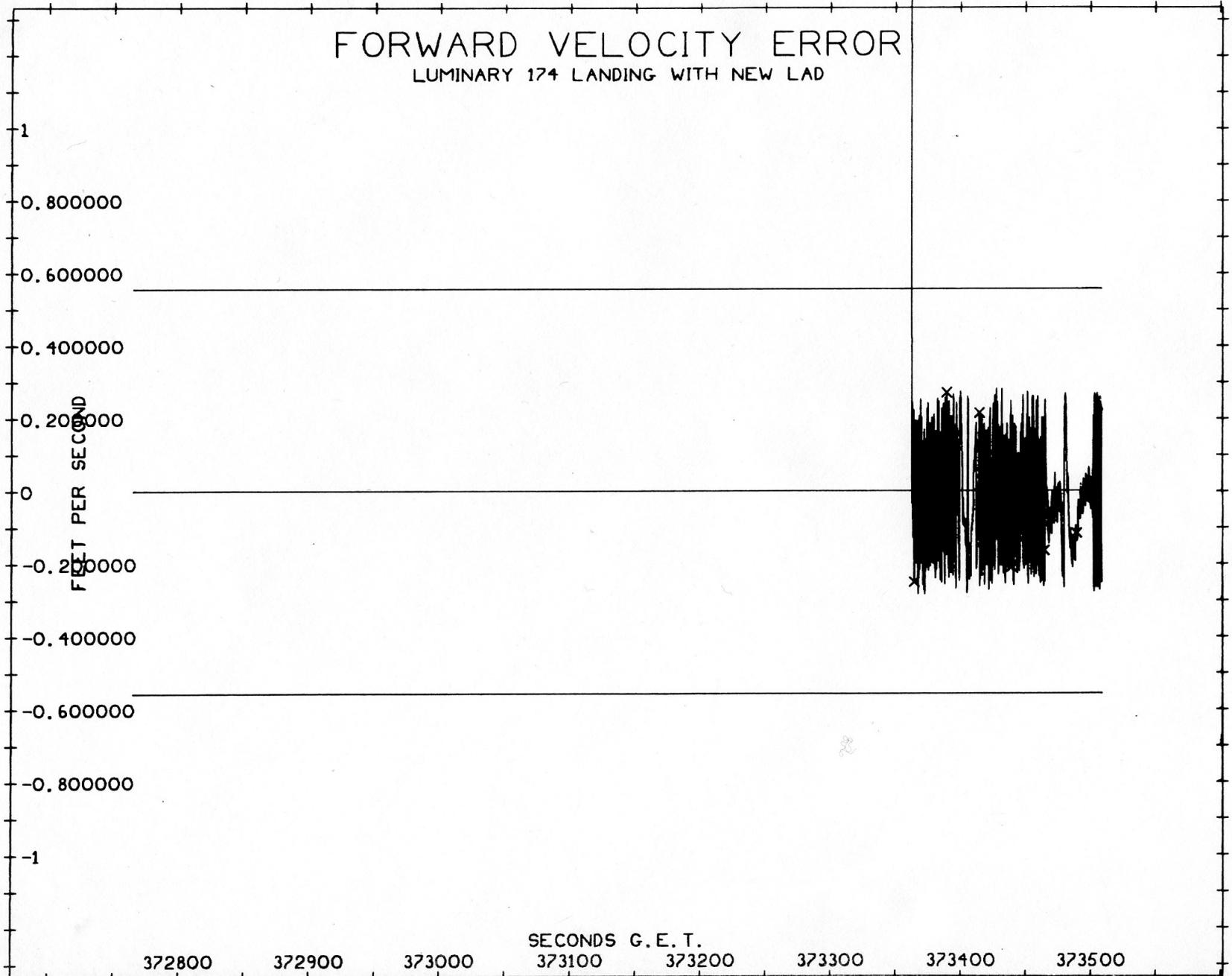
So a display of inertial cross-range velocity is being provided for Ascent (and Aborts). The R10FLAG, whose obituary appeared in the earlier memo, returns from the grave with a new role. Instead of inhibiting all cross-pointer displays it tells the LAD routine to display stable-member (platform) y-axis velocity on the lateral cross-pointer. Since for Ascent the platform is nominally aligned with its y-axis the right-hand normal to the CSM orbital plane — as it is for Descent, and thus Aborts, as well — this display indicates inertial out-of-plane velocity. (Inertial means relative to fixed stable-member coordinates, not relative to the surface like the Descent display.) This assumption of a particular

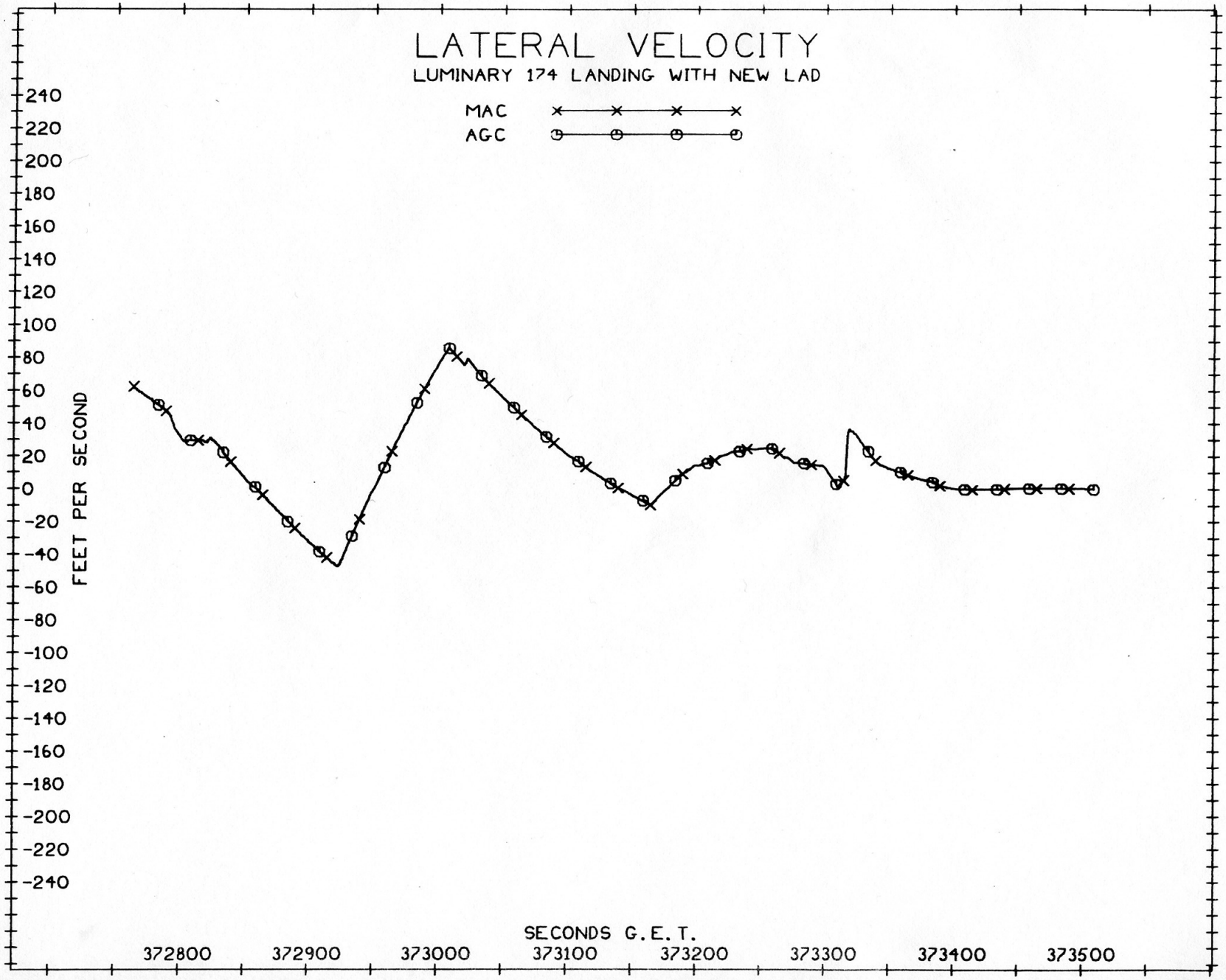
platform alignment for Ascent should now be formally embodied, as it is for Descent, in the GSOP. The forward velocity cross-pointer will be zero during Ascent — at least until someone comes up with something useful to display there.

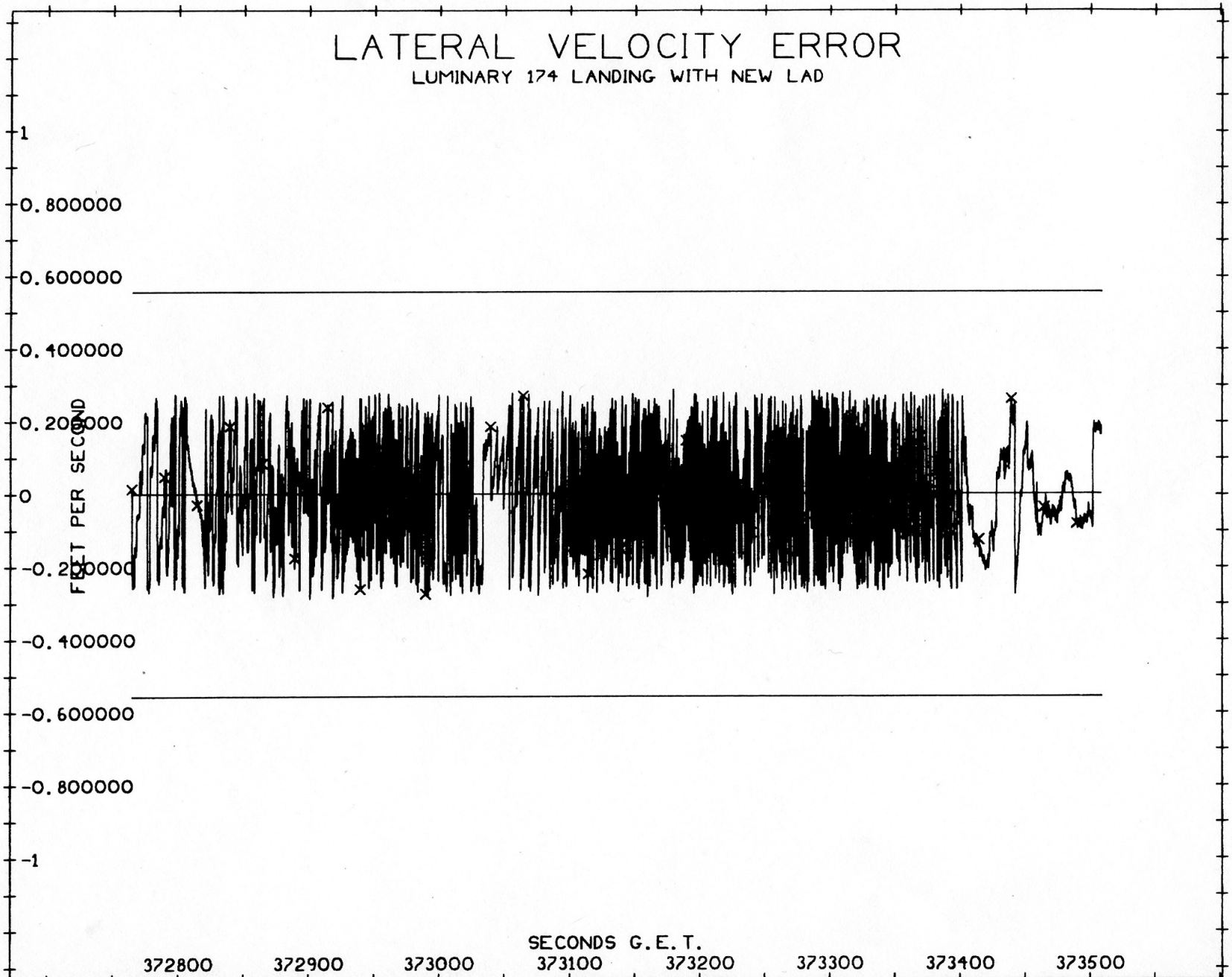
The second purpose of this memo is to present some test results. From a run of LUMINARY revision 174 I am attaching plots of forward velocity, lateral velocity, altitude-rate and altitude, and of the computational errors in each of these values, eight plots in all. The error plots have horizontal lines a ± the size of one output bit. Thus it can be seen at a glance that for the three velocities the displayed value is never as much as one bit in error, and that for altitude the error seldom exceeds one bit. In the earlier memo I said that at higher velocities one bit of error was sometimes seen in the forward velocity display. This error was found to be the fault of the edit program so the new routine is even closer than I thought then to the goal of zero error.

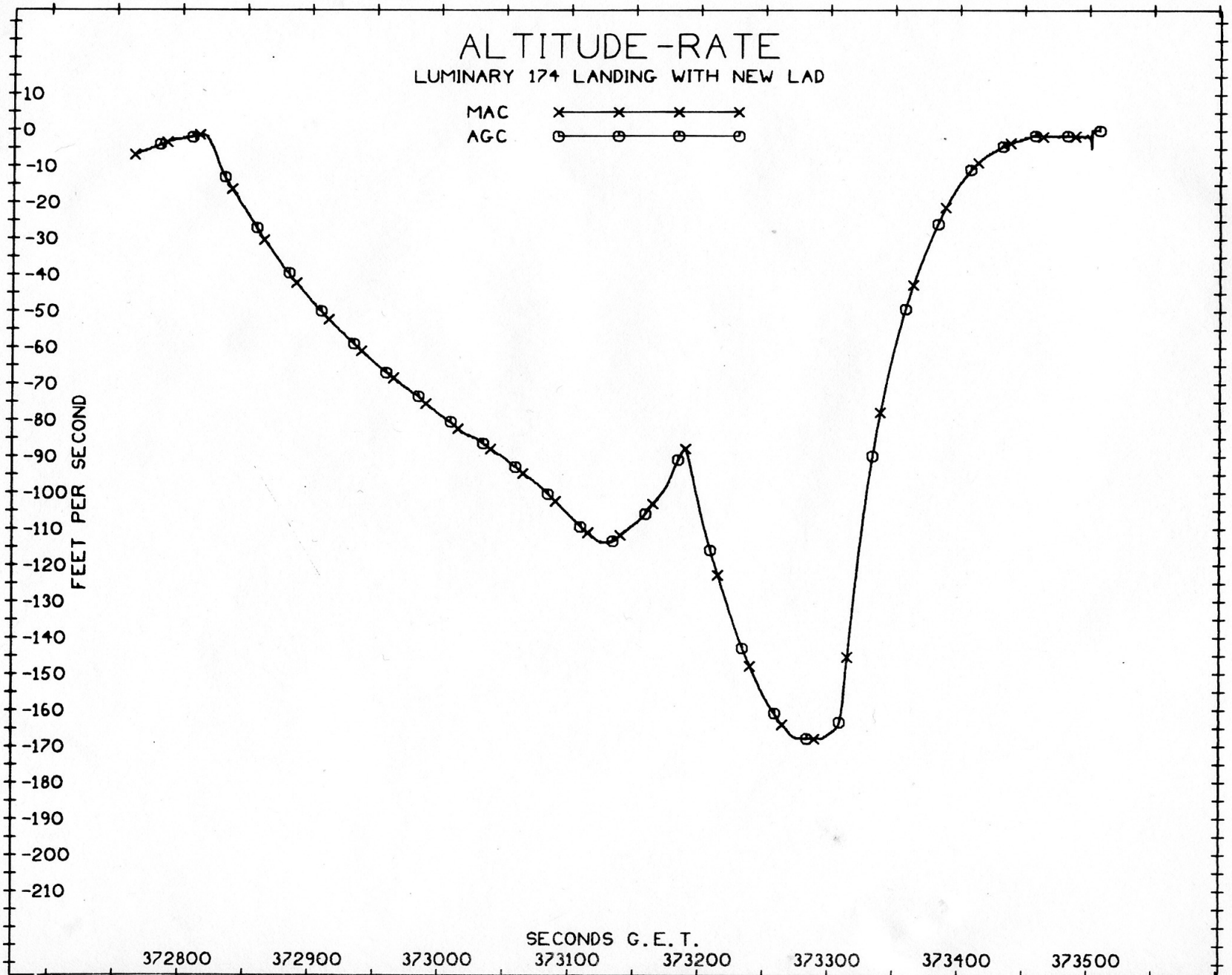
A final adjustment should be noted. Previously there was a 3 centisecond break in the LAD interrupt between the output of altitude-rate and the output of altitude. Because (apparently) in the LMS the sample frequency for the tape meter output is 10 times a second, to make the new meter routine work on these simulators it is necessary to change the break to one of 12 centiseconds. This change has the additional merit of more evenly distributing the LAD interrupt through time, but the minor disadvantage of delaying by about .1 second the appearance of the tape meter displays. This seems preferable to having always to patch LM ropes in order to run them on the LMS.

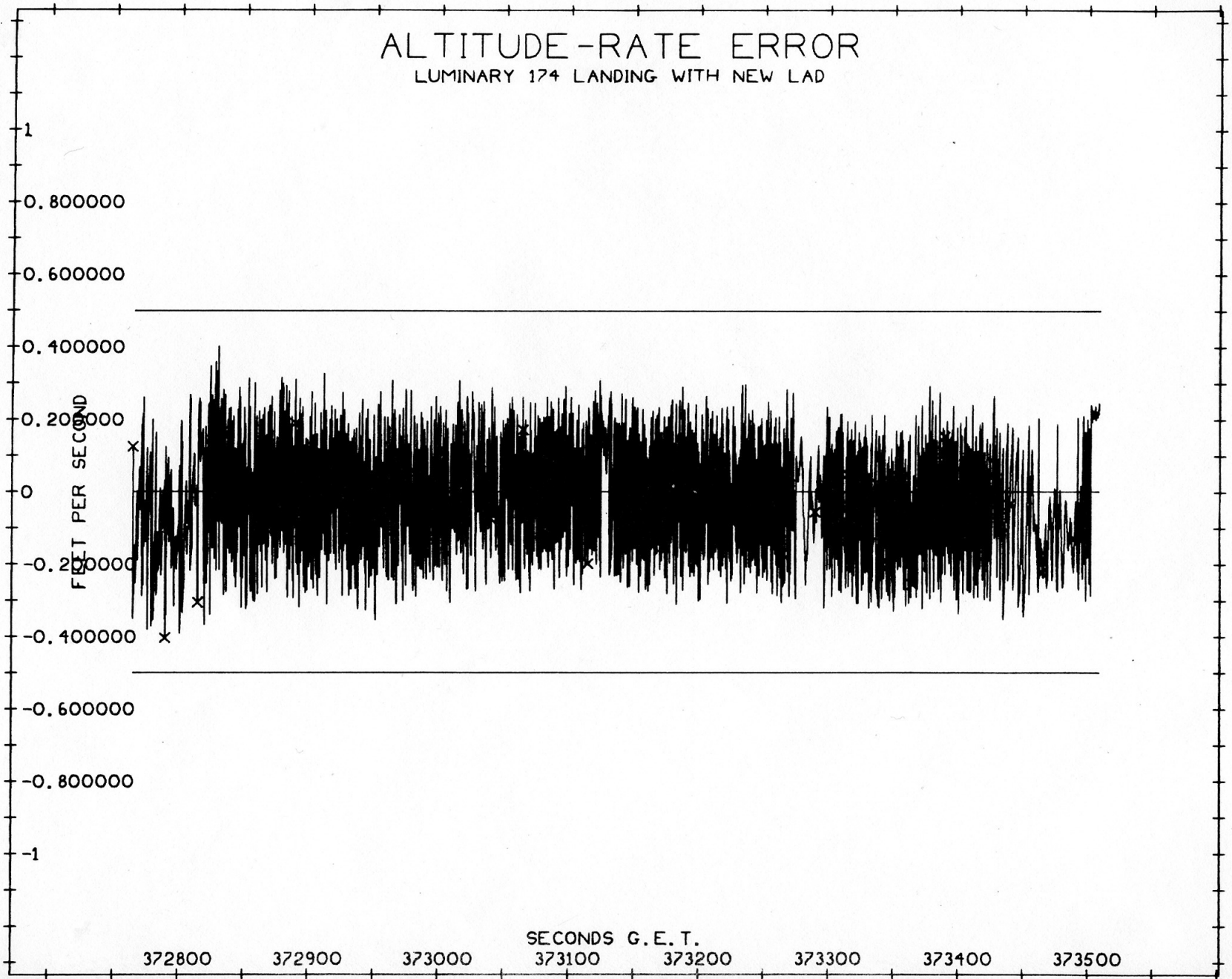

FORWARD VELOCITY
LUMINARY 174 LANDING WITH NEW LAD
MAC
AGC
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
FEET PER SECOND
SECONDS G.E.T.
372800
372900
373000
373100
373200
373300
373400
373500

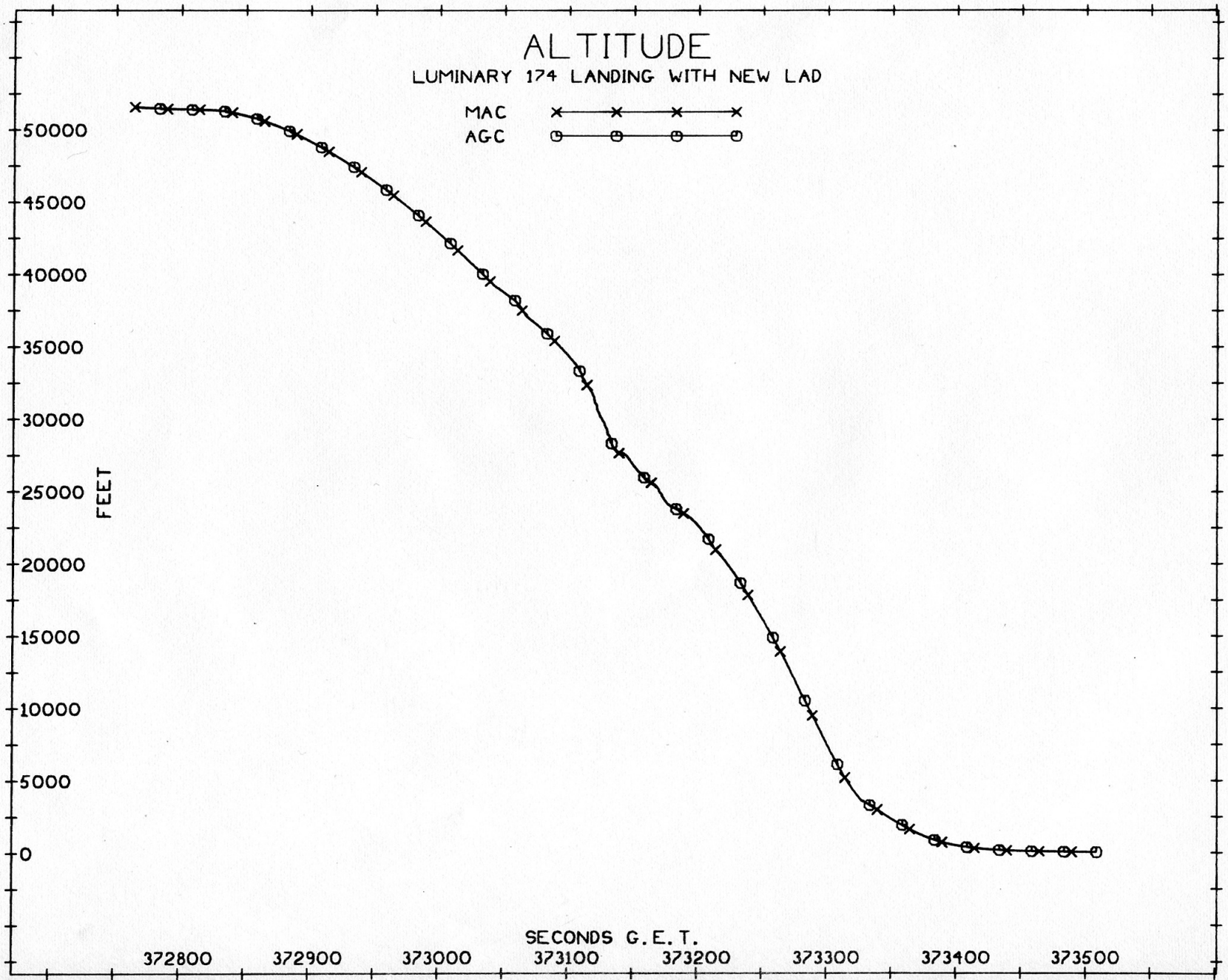

FORWARD VELOCITY ERROR
LUMINARY 174 LANDING WITH NEW LAD
1
0.800000
0.600000
0.400000
0.200000
0
-0.200000
-0.400000
-0.600000
-0.800000
-1
FEET PER SECOND
SECONDS G.E.T.
372800
372900
373000
373100
373200
373300
373400
373500

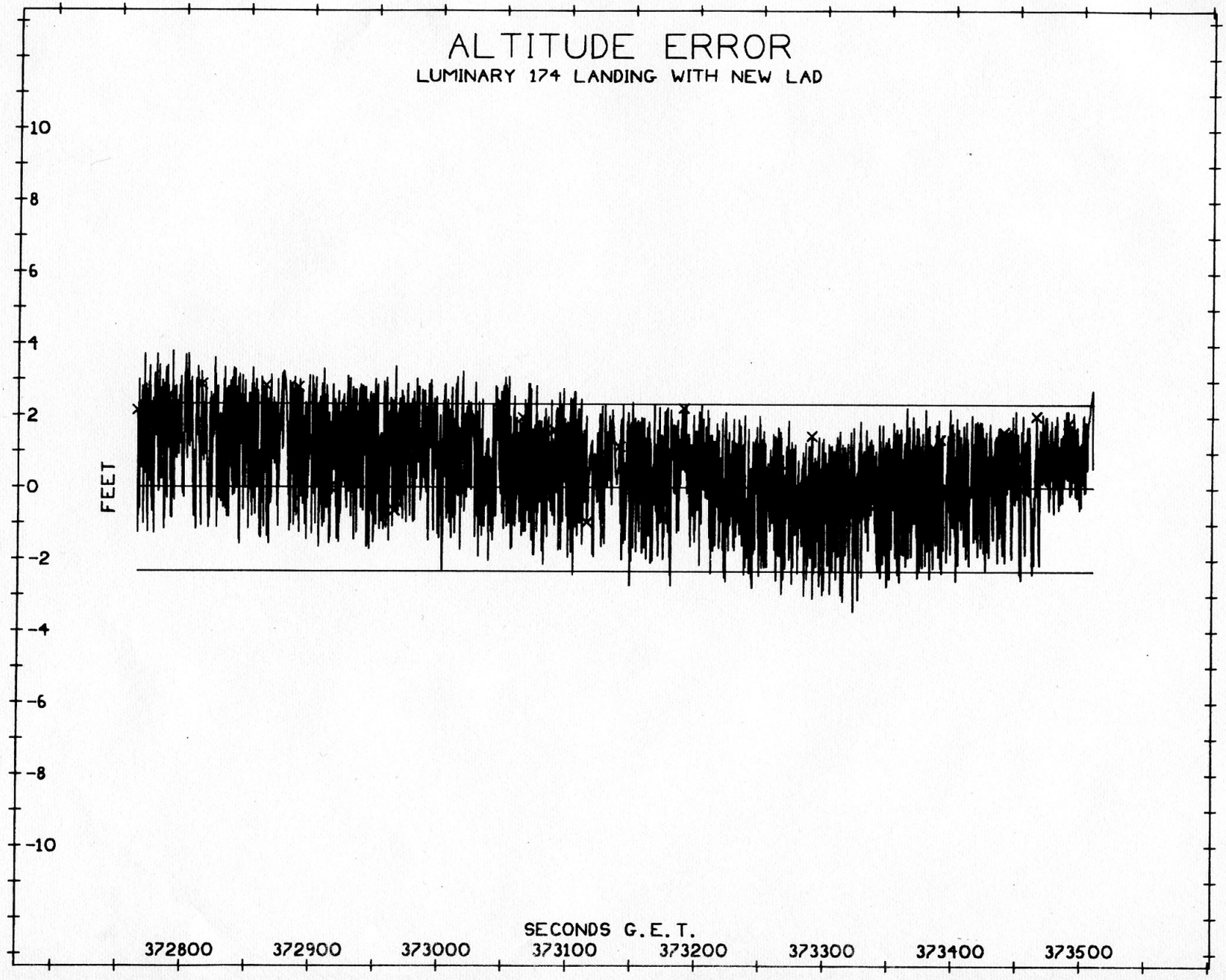

LATERAL VELOCITY
LUMINARY 174 LANDING WITH NEW LAD
MAC
AGC
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
FEET PER SECOND
SECONDS G.E.T.
372800
372900
373000
373100
373200
373300
373400
373500


LATERAL VELOCITY ERROR
LUMINARY 174 LANDING WITH NEW LAD
1
0.800000
0.600000
0.400000
0.200000
0
-0.200000
-0.400000
-0.600000
-0.800000
-1
FEET PER SECOND
SECONDS G.E.T.
372800
372900
373000
373100
373200
373300
373400
373500


ALTITUDE-RATE
LUMINARY 174 LANDING WITH NEW LAD
MAC
AGC
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
FEET PER SECOND
SECONDS G.E.T.
372800
372900
373000
373100
373200
373300
373400
373500


ALTITUDE-RATE ERROR
LUMINARY 174 LANDING WITH NEW LAD
1
0.800000
0.600000
0.400000
0.200000
0
-0.200000
-0.400000
-0.600000
-0.800000
-1
FEET PER SECOND
SECONDS G.E.T.
372800
372900
373000
373100
373200
373300
373400
373500


ALTITUDE
LUMINARY 174 LANDING WITH NEW LAD
MAC
AGC
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
FEET
SECONDS G.E.T.
372800
372900
373000
373100
373200
373300
373400
373500


ALTITUDE ERROR
LUMINARY 174 LANDING WITH NEW LAD
10
8
6
4
2
0
-2
-4
-6
-8
-10
FEET
SECONDS G.E.T.
372800
372900
373000
373100
373200
373300
373400
373500